

Polyculture Experiment Instructions



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 690199

growobservatory.org



About the experiment Why do an experiment? What do we want to find out about? Safety guidelines How to set up the experiment What do I need? Prepare your plots Describe your site Planting and layout Beans Spinach Radish Harvesting and measuring yields When to harvest Weigh your yield and assess quality Assess crop quality Taking notes Analysing your data

About the experiment

Why do this experiment?

Food production and consumption have a big impact on society, soils, ecosystems and biodiversity, and on climate change but most scientific investigation of growing practices that can lessen negative impacts and even help to regenerate soils and ecosystems have been at the larger farm scale.

However, we know that many of these regenerative approaches are practiced at the smaller scale and that individual growers can find these beneficial. So the GROW Observatory developed an

growobservatory.org



experiment to investigate this.

Polycultures – growing several crops together at the same time – have been shown to have benefits in terms of crop yield, resilience to pests and disease, and enhancing wider biodiversity. However, mixes of three or more crops have not been extensively studied and much remains unknown.

This experiment will help you to discover what works best in your own plot. You could also encourage other growers in your community garden or allotment to take part and compare your results. Experiments are even more valuable when several people take part as we can be more sure results are not due to chance.

What do we want to find out about?

This experiment aims to compare harvest quality and yields from three crops grown together in a polyculture with each crop grown separately in a monoculture. The main question is:

1. Is there a difference in yield of beans, spinach and radish when grown as a polyculture compared to when grown as monocultures?

- a) Total yield (grams per square metre)
- b) Yields of each crop

We also want to consider other factors that can affect plant growth. When we cannot control for these, we need to record them so we can understand if and how they influence our results.

Safety guidelines

Please keep safe! Follow the general safety guidelines in the *Research In Your Growing Space Handbook*.



How to set up the experiment

What do I need?

Seeds or seedlings:

- 18 seeds Climbing green beans "cobra" variety Phaseolus vulgaris "Cobra"
- 72 seeds Spinach "matador" variety Spinacia oleacea "Matador"
- 160 seeds Radish "cherry belle" variety Raphanus sativus "Cherry Belle"

It is also worth keeping a few extra seeds for spares in case of germination failure. If these varieties are not available to you, choose closely related varieties of the same species or you could experiment with similar crops suitable for your climate.

Equipment:

- 18 garden canes to support the beans (at least 1.8 metres high)
- Scales to weigh harvests
- Recording sheet or notebook and pencil or pen for observations on the plot
- Gardening tools for preparing the soil, planting seeds, cutting your harvest and watering if you need to

Prepare your plots

There are four plots needed for the experiment. They should be adjacent growing areas that are separated from each other by at least 50 cm. The plots should be free of weeds, and all prepared in the same way according to your usual methods (e.g. dug over, composted for no-dig). The plot sizes needed are:

- 1 metre by 1 metre square (for the polyculture)
- 1 metre by 60 cm (for the beans)
- 1 metre by 40 cm (for the spinach)
- 1 metre by 30 cm (for the radish)

The total site area could therefore be about 2 m by 3 m or a 1 m by 5 m strip. You can arrange



the plots however best fits your space, but we recommend that the two smaller plots are on the sunnier side of the two large plots. It doesn't matter if you practice no-dig or have your specific way of growing, but you must remember to treat each plot in the same way: same watering, fertilising, etc. Ultimately, what you want is for the only difference between them to be the crops that you're growing in them. Otherwise you won't know if any differences in results are because of the different crops or differences in practice.

Describe your site

If you are comparing your results to others, recording your plots' soil texture, light and shade, canopy cover, slope position, angle and aspect in the same way as other people's can help identify differences in yield which are not due to the polyculture and monoculture methods.

Planting and layout

We are going to plant climbing beans which can grow to 2 m tall and need to be supported, spinach which will cover the ground and grow to about 40 cm, and radish, a root crop, the leaves of which will grow to about 20 cm. The polyculture mix will grow in a 1 m^2 , the beans in 1 m by 60 cm, the spinach in 1 m by 40 cm, and the radish along in 1 m by 30 cm plot. When you have marked out the rough size of the plots, you should remove all the weeds, being especially careful to remove the deep rooted ones like dandelions and thistles, and those which spread rapidly like couch grass, bind weed, and creeping buttercup.





Experiment layout diagram

Beans

Plant 9 green beans in each bean plot, so 18 altogether. Depending on where you live, you can plant these straight outside in the ground at a depth of 5 cm when any danger of frost has passed. Alternatively, you might prefer to start them off indoors in pots to plant out in early summer. It's good to use paper pots or cardboard tubes so you don't damage the roots when transplanting them, and the containers will just decompose.

Polyculture – make 3 tripods, placed 20 cm from the plot edge and about 30 cm apart. If it is too early to plant your beans out, leave the tripods to mark where you will plant the other crops.

Monoculture – plant the beans in staggered rows 20 cm apart. Place canes to join between the rows in tripods with two in the first row and one in the second row together, then two from the second row and one from the first row. See the experiment layout diagram above.



Spinach

There will be 36 spinach plants in each plot. These are planted 1.5 cm deep.

Polyculture – place roughly 4 around each bean plant, trying to keep them about 15 cm from the beans and about 10 cm from each other. Check the image above for the polyculture planting layout.

Monoculture – plant in staggered rows about 10 cm apart. 36 seeds makes 4 rows of 9 plants.

Radish

Plant a total of 80 radishes in each plot about 1 cm deep. You can plant them in succession every 2-3 weeks. So long as you plant the same number at the same time in the polyculture and monoculture, you will have a good comparison for the experiment.

Polyculture – if you are in the northern hemisphere, first plant 20 on the north side, so they get the light before the other crops grow. In 2-3 weeks time, plant on the east side, then 2-3 weeks later on the west and another 2-3 weeks, plant on the south.

Monoculture – Plant in two rows of 40 seeds. You'll start on the north-east side and plant the first half a row of 20 seeds the same day as you plant the north side of the polyculture. Then plant the north-west, south-east and south-west at the same time you plant the east, west, and south sides respectively in the polyculture plot.

Planting radish at the edges is sensible because you will be pulling them up after 4-6 weeks to harvest them and you want to minimise the disturbance to the other crops when you do this. Over the coming weeks, you can look for the emergence of your seedlings. Make sure that they get enough water – don't let the ground dry out or get too wet.

Harvesting and measuring yields

Harvesting is perhaps the most satisfying part of growing. It is also an important part of the experiment for data collection. Read and follow the instructions carefully to ensure that your results are accurate and comparable. You could use a notebook to record your measurements or



adapt the data recording sheet at the end of this document. Continue to record your data until your harvests are complete.

When to harvest

Harvest each crop evenly from both plots. Harvesting from only one plot will affect growth in that plot, but not the other.

French beans

Begin picking the pods when they are 10 cm long. Pods are ready when they snap easily and before the beans can be seen through the pod. By picking regularly you can crop plants for several weeks. Cut the beans at the stem using scissors or a sharp knife. Harvest the same proportion e.g. half of what is ready from each plot - if 20 beans are ripe on the polyculture and 40 are ripe on the beans plot (and you don't need them all now) take 10 from the polyculture and 20 from the beans. Weigh from each plot separately.

Spinach

Harvest the leaves continually once they're large enough to pick. Harvest a few leaves from each plant, cutting them off low down with a sharp knife or scissors. Select the outer leaves first and allow the inside ones to keep growing. Spinach leaves are usually nicest as younger "baby" leaves and can be eaten raw or cooked. If they get a bit larger, they might be nicer cooked. Harvest the same proportion from each plot e.g. two leaves from each plant that is ready for harvest.

Radish

You might not know it but you have two options for harvesting your radish!

Roots – the round red-white root is the most commonly eaten part. You ideally want to harvest after 3-4 weeks when they are about 2.5 cm across. Brush away some of the soil above the root with your fingers. If the roots are too small, cover them up again and let them grow a bit more. If it is ready to harvest, hold it at the base of the leaves, just above the root, and pull upwards gently. Harvest as they become ready on each plot. This might not be the same number at the same time. Try not to harvest too early or too late from one plot and not the other.



If the roots have become too large, they can go "woody" and hard and won't be nice to eat. At this point you can leave them to grow and eat the fruits!

Fruits – if you leave a radish to grow on, it will flower with clusters of white-pink flowers with four petals. Leave it a little longer and these will develop long fleshy green seed pods. These seed pods are edible (before they dry out). They taste of radish but are a little milder than the roots. You can get a lot of seed pods from a single plant so this is quite an efficient way to harvest. If you choose to leave some or all of your radish to fruit, take the same number of plants from each plot as roots and fruits.

Weigh your yield and assess quality

This is the most crucial measurement in the experiment. Weigh the harvest of each, from each plot, each time you pick them. It is best to keep scales and your recording sheet or notebook near to your plots (e.g. in a waterproof container or shed). If you can, weigh in grams as this is more precise than ounces.

You should weigh the parts that you are going to eat (as if you bought them from the shop):

- Beans weigh the pods before washing. Stems should be removed.
- Spinach weigh the leaves. Shake off any dirt, but do not wash them as this will make them heavier.
- Radish weigh either the roots or the pods. Leaves and stems should be removed, along with the root tip. Brush off any dirt on the root, or give it a quick rinse and pat dry.

Assess crop quality

Quality can be assessed against a simple scale: how much of the harvested crop (that you just weighed) is good to eat?

- 0 -none of the crop
- 1 -some, but less than a quarter
- 2-a quarter up to a half
- 3 a half up to three quarters
- 4 more than three-quarters of it



Taking notes

Other aspects of growing could affect your results, so it's useful to record notes. This can be used to help understand any odd results you get later. For example:

- Harvest quality if less than perfect, what do you see as causing the problem?
- Weather e.g. has it been rainy or hot since your last record?
- Activity e.g. have you weeded or watered the plot(s)?
- Time spent how long have you worked on each of the four plots?
- Damage any signs of pests or disease? On which plot(s)?

Differences – are plants growing differently in each plot? Has anything else happened that could affect the plants in one plot?

Analysing your data

Before we can prepare our data for analysis, we need to have the research question in our minds and consider what data exactly we will need to answer it and in what format. As a reminder, for this experiment the main question is: Is there a difference in total yield (grams per square metre) between the polyculture and monoculture plots?

To answer this, we need to add up all the yields of each crop throughout the season for the monocultures and then for the polyculture. Then we need to account for the differences in the size of plots. The polyculture was 1 square metre (100 by 100 cm) whereas the monoculture plots were one metre long by 60, 40 and 30 cm. That is a total of 100 cm by 130 cm or 1.3 square metres.

This will give us an overall answer to the question – can polycultures yield more from the same area as monocultures? We might then also want to break this down to see what contribution each crop made to the total and if there are any differences in their productivity between the polyculture and monoculture plots. Taking a look at your data as an image such as graph or map can help give a quick answer to most questions.



Date (day/month)	Crop B – Beans S – Spinach Rr - Radish root Rp - Radish seed pod	Plot P – polyculture M - monoculture	Weight Mark your units above	Quality (0-5)	Notes e.g. weather, activity on plot, time spent on plot, pest/disease signs, plot differences, questions for the forum
e.g. 14/06/2018	S	М	550 g	5	Dry and sunny all week, Spent 2 mins a day watering seedlings in each plot. Spinach in polyculture seems to be greener than that in monoculture.



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant

agreement No 690199.